From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

To:

CONARD, Richard, D.
Barnes & Thornburg
11 South Meridian Street
Indianapolis, IN 46204
ETATS-UNIS D'AMERIQUE

Date of mailing (day/month/year)
03 September 2001 (03.09.01)

Applicant's or agent's file reference
20568-64399

IMPORTANT NOTIFICATION

International application No.
PCT/US00/00105

International filing date (day/month/year)
04 January 2000 (04.01.00)

1. The following indications appeared on record concerning:

[X] the applicant [ ] the inventor [ ] the agent [ ] the common representative

Name and Address
CHROMATIS NETWORKS, INC.
Suite 806
Three Bethesda Metro Center
Bethesda, MD 20814
United States of America

State of Nationality: US
State of Residence: US
Telephone No.:
Facsimile No.:
Teleprinter No.:

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

[ ] the person [ ] the name [X] the address [ ] the nationality [ ] the residence

Name and Address
CHROMATIS NETWORKS, INC.
Suite 500
450 Spring Park Place
Herndon, VA 20170
United States of America

State of Nationality: US
State of Residence: US
Telephone No.: (703) 689-2985
Facsimile No.: (703) 481-7333
Teleprinter No.:

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

[X] the receiving Office
[ ] the International Searching Authority
[X] the International Preliminary Examining Authority
[ ] the designated Offices concerned
[X] the elected Offices concerned
[ ] other:

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland
Facsimile No.: (41-22) 740.14.35

Authorized officer
François BAECHLER
Telephone No.: (41-22) 338.83.38

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Commissioner
US Department of Commerce
United States Patent and Trademark
Office, PCT
2011 South Clark Place Room
CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 12 January 2001 (12.01.01)	
International application No. PCT/US00/00105	**Applicant's or agent's file reference** 20568-64399
International filing date (day/month/year) 04 January 2000 (04.01.00)	**Priority date** (day/month/year) 07 June 1999 (07.06.99)
Applicant OREN, Yair	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

28 September 2000 (28.09.00)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer R. E. Stoffel
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

Express Mail No.: EL230047934US

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To: RICHARD D. CONARD
BARNES & THORNBURG
11 SOUTH MERIDIAN STREET
INDIANAPOLIS IN 46204

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT OR THE DECLARATION

(PCT Rule 44.1)

	Date of Mailing *(day/month/year)* 28 AUG 2000
Applicant's or agent's file reference 20568-64399	**FOR FURTHER ACTION** **See paragraphs 1 and 4 below**
International application No. PCT/US00/00105	International filing date *(day/month/year)* 04 JANUARY 2000
Applicant CHROMATIS NETWORKS INC.	

1. [X] The applicant is hereby notified that the international search report has been established and is transmitted herewith.

Filing of amendments and statement under Article 19:
The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

When? The time limit for filing such amendments is normally 2 months from the date of transmittal of the international search report; however, for more details, see the notes on the accompanying sheet.

Where? Directly to the International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland
Facsimile No.: (41-22) 740.14.35

For more detailed instructions, see the notes on the accompanying sheet.

2. [ ] The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.

3. [ ] **With regard to the protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

[ ] the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

[ ] no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Further action(s):** The applicant is reminded of the following:

Shortly after **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in rules 90 *bis* 1 and 90 *bis* 3, respectively, before the completion of the technical preparations for international publication.

Within **19 months** from the priority date, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later).

Within **20 months** from the priority date, the applicant must perform the prescribed acts for entry into the national phase before all designated Offices which have not been elected in the demand or in a later election within 19 months from the priority date or could not be elected because they are not bound by Chapter II.

Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	Authorized officer JASON CHAN Eugenia Zogan
Facsimile No. (703) 305-3988	Telephone No. (703) 305-4729

(See notes on accompanying sheet)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 20568-64399	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
International application No. PCT/US00/00105	International filing date *(day/month/year)* 04 JANUARY 2000	(Earliest) Priority Date *(day/month/year)* 07 JUNE 1999
Applicant CHROMATIS NETWORKS INC.		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 2 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing:

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readable form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (See Box II).

4. With regard to the **title**,

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 13

   [X] as suggested by the applicant.

   [ ] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

   [ ] None of the figures.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/00105

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :H04B 10/00, 10/04, 10/06, 10/12, 10/28
US CL :359/118, 119, 152, 154, 164

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 359/118, 119, 152, 154, 164

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

IEEE DATABASE
search term: ring network, node, transceiver

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,647,035 A (CADEDDU et al) 08 JULY 1997, FIGURES 1-6	1-27
Y	US 4,482,980 A (KOROWITZ et al) 13 NOVEMBER 1984, FIGURES 1, 2, AND 4	1-27
Y	US 5,406,401 A (KREMER) 11 APRIL 1995, FIGURES 1 AND 2	1-27
Y	US 4,704,713 A (HALLER et al) 03 NOVEMBER 1987, FIGURES 2A, 3	1-27
Y	US 4,837,856 A (GLISTA, JR) 06 JUNE 1989, FIGURES 2, 5	1-27

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

16 MAY 2000

Date of mailing of the international search report

28 AUG 2000

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. (703) 305-3988

Authorized officer

JASON CHAN Eugenia Zogan

Telephone No. (703) 305-4729

Form PCT/ISA/210 (second sheet) (July 1998)★

PCT

GENERAL POWER OF ATTORNEY

(for several international applications filed under the Patent Cooperation Treaty)

(PCT Rule 90.5)

The undersigned person(s) :
(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

CHROMATIS NETWORKS, INC.
Three Bethesda Metro Center, Suite 700
Bethesda, MD 20814
US

hereby appoint(s) the following person as: [X] agent [ ] common representative

Name and address
(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

CONARD, Richard D.; COFFEY, William R.; HYLAND, Jerry E.; LAMMERT, Steven R.; REZEK, Richard A.; NIEDNAGEL, Timothy E.; BREEN, John P.; WOODBURN, Jill L.; HARRISON, Nancy, J.; CARTER, R. Trevor; KULKARNI, Dilip A.; QUICK, David B.; POWLICK, Jill T.; PALAN, Perry; NEWMAN, Mark M.; GILLENWATER, Bobby B.; HUNT, Paul B.; GZYBOWSKI, Michael S.; GALLAGHER, Gerald T.; NULL, Robert D.; MARTIN, Alice O.; All Appointed Agents of the Address:

BARNES & THORNBURG
11 South Meridian Street
Indianapolis, IN 46204
US

to represent the undersigned before

[X] all the competent International Authorities
[ ] the International Searching Authority only
[ ] the International Preliminary Examining Authority only

in connection with any and all international applications filed by the undersigned with the following Office

US as receiving Office

and to make or receive payments on behalf of the undersigned.

Signature(s) *(where there are several persons, each of them must sign; next to each signature, indicate the name of the person signing and the capacity in which the person signs, if such capacity is not obvious from reading this power)*:

Signature of Officer

Date: 11 02 1999
Day/ Month/ Year

Typed or Printed Name : Rafi Gidron

Title: President

Form PCT/Model of general power of attorney (for several international applications) (July 1992)

PCT

GENERAL POWER OF ATTORNEY

(for several international applications filed under the Patent Cooperation Treaty)

(PCT Rule 90.5)

The undersigned person(s) :
(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

OREN, Yair
13 Dissenchik Street
Tel-Aviv
IL 69353

hereby appoint(s) the following person as: [X] agent [ ] common representative

Name and address
(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

CONARD, Richard D.; COFFEY, William R.; HYLAND, Jerry E.; LAMMERT, Steven R.; REZEK, Richard A.; NIEDNAGEL, Timothy E.; BREEN, John P.; WOODBURN, Jill L.; HARRISON, Nancy, J.; CARTER, R. Trevor; KULKARNI, Dilip A.; QUICK, David B.; POWLICK, Jill T.; PALAN, Perry; NEWMAN, Mark M.; GILLENWATER, Bobby B.; HUNT, Paul B.; GZYBOWSKI, Michael S.; GALLAGHER, Gerald T.; NULL, Robert D.; MARTIN, Alice O.; All Appointed Agents of the Address:

BARNES & THORNBURG
11 South Meridian Street
Indianapolis, IN 46204
US

to represent the undersigned before

[X] all the competent International Authorities
[ ] the International Searching Authority only
[ ] the International Preliminary Examining Authority only

in connection with any and all international applications filed by the undersigned with the following Office

US as receiving Office

and to make or receive payments on behalf of the undersigned.

Signature(s) *(where there are several persons, each of them must sign; next to each signature, indicate the name of the person signing and the capacity in which the person signs, if such capacity is not obvious from reading this power):*

Yair OREN

Date: 7 2 1999
Day/ Month/ Year

Form PCT/Model of general power of attorney (for several international applications) (July 1992)

Express Mail [redacted]: EL230047934US

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No.

International Filing Date

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference *(if desired) (12 characters maximum)* 20568-64399

Box No. I TITLE OF INVENTION

DUAL HOMING FOR DWDM NETWORKS IN FIBER RINGS

Box No. II APPLICANT

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

CHROMATIS NETWORKS, INC.
Three Bethesda Metro Center, Suite 700
Bethesda, MD 20814
US

☐ This person is also inventor.

Telephone No. (301) 664-8499

Facsimile No. (301) 657-9776

Teleprinter No.

State *(that is, country)* of nationality: US

State *(that is, country)* of residence: US

This person is applicant for the purposes of: ☐ all designated States ☒ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

OREN, Yair
13 Dissenchik Street
Tel-Aviv
IL 69353

This person is:

☐ applicant only

☒ applicant and inventor

☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality: IL

State *(that is, country)* of residence: IL

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

CONARD, Richard D.
BARNES & THORNBURG
11 South Meridian Street
Indianapolis, IN 46204
US

Telephone No. (317) 236-1313

Facsimile No. (317) 231-7433

Teleprinter No.

☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Box No.V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) *(mark the applicable check-boxes; at least one must be marked)*:

Regional Patent

- ☐ **AP** **ARIPO Patent:** **GH** Ghana, **GM** Gambia, **KE** Kenya, **LS** Lesotho, **MW** Malawi, **SD** Sudan, **SL** Sierra Leone, **SZ** Swaziland, **TZ** United Republic of Tanzania, **UG** Uganda, **ZW** Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT
- ☐ **EA** **Eurasian Patent:** **AM** Armenia, **AZ** Azerbaijan, **BY** Belarus, **KG** Kyrgyzstan, **KZ** Kazakhstan, **MD** Republic of Moldova, **RU** Russian Federation, **TJ** Tajikistan, **TM** Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT
- ☒ **EP** **European Patent:** **AT** Austria, **BE** Belgium, **CH and LI** Switzerland and Liechtenstein, **CY** Cyprus, **DE** Germany, **DK** Denmark, **ES** Spain, **FI** Finland, **FR** France, **GB** United Kingdom, **GR** Greece, **IE** Ireland, **IT** Italy, **LU** Luxembourg, **MC** Monaco, **NL** Netherlands, **PT** Portugal, **SE** Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT
- ☐ **OA** **OAPI Patent:** **BF** Burkina Faso, **BJ** Benin, **CF** Central African Republic, **CG** Congo, **CI** Côte d'Ivoire, **CM** Cameroon, **GA** Gabon, **GN** Guinea, **GW** Guinea-Bissau, **ML** Mali, **MR** Mauritania, **NE** Niger, **SN** Senegal, **TD** Chad, **TG** Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT *(if other kind of protection or treatment desired, specify on dotted line)* .....

National Patent *(if other kind of protection or treatment desired, specify on dotted line)*:

- ☐ **AE** United Arab Emirates
- ☐ **AL** Albania
- ☐ **AM** Armenia
- ☐ **AT** Austria
- ☒ **AU** Australia
- ☐ **AZ** Azerbaijan
- ☐ **BA** Bosnia and Herzegovina
- ☐ **BB** Barbados
- ☐ **BG** Bulgaria
- ☐ **BR** Brazil
- ☐ **BY** Belarus
- ☐ **CA** Canada
- ☐ **CH and LI** Switzerland and Liechtenstein
- ☐ **CN** China
- ☐ **CR** Costa Rica
- ☐ **CU** Cuba
- ☐ **CZ** Czech Republic
- ☐ **DE** Germany
- ☐ **DK** Denmark
- ☐ **DM** Dominica
- ☐ **EE** Estonia
- ☐ **ES** Spain
- ☐ **FI** Finland
- ☐ **GB** United Kingdom
- ☐ **GD** Grenada
- ☐ **GE** Georgia
- ☐ **GH** Ghana
- ☐ **GM** Gambia
- ☐ **HR** Croatia
- ☐ **HU** Hungary
- ☐ **ID** Indonesia
- ☒ **IL** Israel
- ☐ **IN** India
- ☐ **IS** Iceland
- ☒ **JP** Japan
- ☐ **KE** Kenya
- ☐ **KG** Kyrgyzstan
- ☐ **KP** Democratic People's Republic of Korea .....
- ☒ **KR** Republic of Korea
- ☐ **KZ** Kazakhstan
- ☐ **LC** Saint Lucia
- ☐ **LK** Sri Lanka
- ☐ **LR** Liberia
- ☐ **LS** Lesotho
- ☐ **LT** Lithuania
- ☐ **LU** Luxembourg
- ☐ **LV** Latvia
- ☐ **MA** Morocco
- ☐ **MD** Republic of Moldova
- ☐ **MG** Madagascar
- ☐ **MK** The former Yugoslav Republic of Macedonia .....
- ☐ **MN** Mongolia
- ☐ **MW** Malawi
- ☐ **MX** Mexico
- ☐ **NO** Norway
- ☐ **NZ** New Zealand
- ☐ **PL** Poland
- ☐ **PT** Portugal
- ☐ **RO** Romania
- ☐ **RU** Russian Federation
- ☐ **SD** Sudan
- ☐ **SE** Sweden
- ☐ **SG** Singapore
- ☐ **SI** Slovenia
- ☐ **SK** Slovakia
- ☐ **SL** Sierra Leone
- ☐ **TJ** Tajikistan
- ☐ **TM** Turkmenistan
- ☐ **TR** Turkey
- ☐ **TT** Trinidad and Tobago
- ☐ **TZ** United Republic of Tanzania
- ☐ **UA** Ukraine
- ☐ **UG** Uganda
- ☒ **US** United States of America
- ☐ **UZ** Uzbekistan
- ☐ **VN** Viet Nam
- ☐ **YU** Yugoslavia
- ☐ **ZA** South Africa
- ☐ **ZW** Zimbabwe

Check-boxes reserved for designating States which have become party to the PCT after issuance of this sheet:

- ☐ .....
- ☐ .....

Precautionary Designation Statement: In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. *(Confirmation (including fees) must reach the receiving Office within the 15-month time limit.)*

Box No. VI PRIORITY CLAIM ☐ Further priority claims are indicated in the Supplemental Box.

Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is: national application: country	regional application:* regional Office	international application: receiving Office
item (1) (07.06.99) 07 June 1999	60/137,983	US		
item (2)				
item (3)				

☒ The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office)* identified above as item(s): (1)

* *Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See Supplemental Box.*

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):*

ISA / US

Request to use results of earlier search; reference to that search *(if an earlier search has been carried out by or requested from the International Searching Authority):*

Date *(day/month/year)* Number Country *(or regional Office)*

Box No. VIII CHECK LIST; LANGUAGE OF FILING

This international application contains the following **number of sheets**:

request	:	3
description (excluding sequence listing part)	:	10
claims	:	4
abstract	:	1
drawings	:	6
sequence listing part of description	:	0
Total number of sheets	:	24

This international application is **accompanied by** the item(s) marked below:

1. ☒ fee calculation sheet
2. ☐ separate signed power of attorney
3. ☒ copy of general power of attorney; reference number, if any: (2)
4. ☐ statement explaining lack of signature
5. ☐ priority document(s) identified in Box No. VI as item(s):
6. ☐ translation of international application into (language):
7. ☐ separate indications concerning deposited microorganism or other biological material
8. ☐ nucleotide and/or amino acid sequence listing in computer readable form
9. ☒ other *(specify)*: Transmittal Letter to the US/RO Return Postal Card

Figure of the drawings which should accompany the abstract: 13

Language of filing of the international application: English

Box No. IX SIGNATURE OF APPLICANT OR AGENT

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

Richard D. Conard

Richard D. Conard, Agent for Applicants

For receiving Office use only

1. Date of actual receipt of the purported international application:
2. Drawings: ☐ received: ☐ not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:
4. Date of timely receipt of the required corrections under PCT Article 11(2):
5. International Searching Authority (if two or more are competent): ISA /
6. ☐ Transmittal of search copy delayed until search fee is paid.

For International Bureau use only

Date of receipt of the record copy by the International Bureau:

See Notes to the request form

Express Mail No.: EL230047934US

PCT

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:
RICHARD D. CONARD
BARNES & THORNBURG
11 SOUTH MERIDIAN STREET
INDIANAPOLIS, IN 46204

RECEIVED
AUG 04 2001
BARNES & THORNBURG

NOTIFICATION OF TRANSMITTAL OF INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Rule 71.1)

Date of Mailing *(day/month/year)*	02 AUG 2001
Applicant's or agent's file reference 20568-64399	**IMPORTANT NOTIFICATION**

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US00/00105	04 January 2000 (04.01.2000)	07 June 1999 (07.06.1999)

Applicant

CHROMATIS NETWORKS, INC.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices)(Article 39(1))(see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230	Authorized officer Jason Chan Telephone No. (703)305-3900

Form PCT/IPEA/416 (July 1992)

ENT COOPERATION TREA

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 20568-64399	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/US00/00105	International filing date *(day/month/year)* 04 January 2000 (04.01.2000)	Priority date *(day/month/year)* 07 June 1999 (07.06.1999)
International Patent Classification (IPC) or national classification and IPC IPC(7): H04B 10/00, 10/04, 10/06, 10/12, 10/28 and US Cl.: 359/118, 119, 152, 154, 164		
Applicant CHROMATIS NETWORKS, INC.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 7 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 0 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of report with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
28 September 2000 (28.09.2000)	15 JANUARY 2001
Name and mailing address of the IPEA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230	Authorized officer Jason Chan Telephone No. (703)305-3900

Karen L. Ward

Form PCT/IPEA/409 (cover sheet)(July 1998)

INTERNATIONAL PRELIM[redacted]RY EXAMINATION REPORT

International [redacted]lication No.
PCT/US0[redacted]0105

I. Basis of the report

1. With regard to the **elements** of the international application:*

☒ the international application as originally filed.

☒ the description:
pages 1-10 as originally filed
pages NONE ; filed with the demand
pages NONE , filed with the letter of _____.

☒ the claims:
pages 11-14 , as originally filed
pages NONE , as amended (together with any statement) under Article 19
pages NONE , filed with the demand
pages NONE , filed with the letter of _____.

☒ the drawings:
pages 1-6 , as originally filed
pages NONE , filed with the demand
pages NONE , filed with the letter of _____.

☐ the sequence listing part of the description:
pages NONE , as originally filed
pages NONE , filed with the demand
pages NONE , filed with the letter of _____.

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language _____ which is:

☐ the language of a translation furnished for the purposes of international search (under Rule23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination(under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in printed form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☒ The amendments have resulted in the cancellation of:

☒ the description, pages NONE

☒ the claims, Nos. NONE

☒ the drawings, sheets/~~fig~~ NONE

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

** Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

*** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.*

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. STATEMENT

Novelty (N)	Claims 1-27	YES
	Claims NONE	NO
Inventive Step (IS)	Claims NONE	YES
	Claims 1-27	NO
Industrial Applicability (IA)	Claims 1-27	YES
	Claims NONE	NO

2. CITATIONS AND EXPLANATIONS (Rule 70.7)
Please See Continuation Sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the questions whether the claims are fully supported by the description, are made:

The drawings are objected to under PCT Rule 66.2(a)(v) as lacking clarity under PCT Article 7 because: the applicant claims a plurality of receivers and transmitters but fails to show them in the drawings (e.g. "fifth receiver" "sixth receiver").

The description is objected to under PCT Rule 66.2(a)(v) as lacking clarity under PCT Article 5 because it fails to contain an adequate written description of the plurality of receivers claimed throughout the application. The description is inadequate because: although the applicant claims a "third" through "sixth" receiver in the node, the applicant fails to disclose these receivers in the specification.

Claims 2 and 7-12 are objected to as lacking clarity under PCT Rule 66.2(a)(v) because practice of the claimed invention is not adequately described in writing, as required under PCT Rule 5.1(a)(iii), for the reasons set forth in the immediately preceding paragraph.

Claims 2 and 7-12 are objected to under PCT Rule 66.2(a)(v) as lacking clarity under PCT Article 6 because claims 2 and 7-12 are indefinite for the following reason(s): it is not clear to the examiner whether there are more than two receivers in certain nodes or whether the applicant has used a way of labeling certain receivers according to which node they are in.

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of Certain Documents Cited

1. Certain published documents (Rule 70.10)

Application No / Patent No.	Publication Date (day/month/year)	Filing Date (day/month/year)	Priority date (valid claim) (day/month/year)
None	None	None	None

2. Non-written disclosures (Rule 70.9)

Kind of non-written disclosure	Date of non-written disclosure (day/month/year)	Date of written disclosure referring to non-written disclosure (day/month/year)
None	None	None

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

V. 2. Citations and Explanations:

Claims 1-12 and 22-27 lack an inventive step under PCT Article 33(3) as being obvious over Korowitz (U.S. Patent Number 4,482,980).

Regarding Claim 1, Korowitz teaches first and second optical fibers for carrying information modulated on an optical carrier (reference numerals 28, 30 in Figure 1), at least two nodes at a first one of which information modulated on the carrier is to be recovered and transmitted (column 4 lines 46-51), the first node including apparatus for receiving and transmitting the information (reference numeral 24, 25 in Figure 1), the apparatus for receiving and transmitting the information including a first receiver (reference numeral 32 in Figure 2) for recovering the information from the optical carrier carried on the first optical fiber, a second receiver (the optical detector in OEI 25 in Figure 2) for recovering information modulated on the optical carrier carried on the second optical fiber, a transmitter for modulating data information on the second optical fiber (the optical transmitter in OEI 25 in Figure 2) and a first splitter for splitting a signal carried on the first optical fiber, the first splitter coupled to the first optical fiber and the first receiver (reference numeral 36 in Figure 2). Korowitz differs from the claimed invention in that Korowitz fails to specifically teach a first optical splitter for splitting the optical carrier on the first optical fiber. One skilled in the art would clearly have recognized that although Korowitz teaches an electrical splitter and selector (reference numeral 36 in Figure 2) for splitting a converted optical signal to one of three electrical lines, one could have easily chosen to employ an all optical approach in order to reduce the possibility of signal loss due to conversion from and optical signal to an electrical signal. One skilled in the art would have been have further been motivated to use an all optical approach in order to increase reliability, being that the electrical splitter and selector taught by Korowitz is susceptible to mechanical failure. Therefore, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to use a splitter capable of slitting the optical carrier carried on the first optical fiber (an optical splitter) as opposed to an the electrical splitter and selector taught by Korowitz in order to avoid signal loss and to increase reliability.

Claims 2, 8, 10, and 12 recite limitations similar to those of claim 1. Therefore, claims 2, 8, 10, and 12 lack an inventive step for the same reasons as those stated regarding claim 1 above. Furthermore, mere duplication of parts for a multiplied effect is not the type of innovation for which a patent monopoly is to be granted.

Regarding Claims 3-6 and 22-27 Korowitz teaches a means for recovering an optical carrier from and returning an optical carrier to the first and second optical fiber (see Figure 2).

Regarding Claims 7, 9, and 11, although Korowitz fails to teach a third or fourth receiver as claimed, mere duplication of parts for a multiplied effect is not the type of innovation for which a patent monopoly is to be granted.

Claims 13-21 lack an inventive step under PCT Article 33(3) as being obvious over Korowitz (U.S. Patent Number 4,482,980) in

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

view of Haller (U.S. Patent Number 4,704,713).

Regarding Claims 13, 14, 16, 17, 19, and 21, Korowitz differs from the claim invention in that Korowitz fails to teach that the first and second receiver are coupled to a selection function which selects between the optical carrier from the first optical fiber and the optical carrier from the second optical fiber. However, Korowitz does suggest a recovery feature that allows one node to circumvent problem nodes in the event of a fault in the system (column 9 lines 4-42). One skilled in the art would clearly have recognized that in order to prevent loss of information in an optical communication system, one could have used a working and a protection fiber and further would have recognized the benefits of having the ability to switch between the two fibers in the event of a fault in the system. Haller, in the same filed of endeavor, teaches that it is well known in the art to employ a selection function that selects which of two receivers will receive a signal from one of two optical carriers from one of two optical fibers (reference numeral 241 in Figure 2b) in the event of a fault in the system. One skilled in the art would clearly have appreciated the ability to use the teachings of Haller in the device of Korowitz in order to achieve a selection means between two fibers. Therefore, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to employ a selection function which selects between the optical carrier from the first or second optical fiber, as taught by Haller, and apply those teachings to the device of Korowitz in order to prevent the loss of information in the event of a fault in the system.

Claims 15, 18, and 20 recite limitations similar to those of claims 13, 14, 16, 17, 19, and 21. Therefore, claims 15, 18, and 20 lack an inventive step for the same reasons as those stated regarding claims 13, 14, 16, 17, 19, and 21 above.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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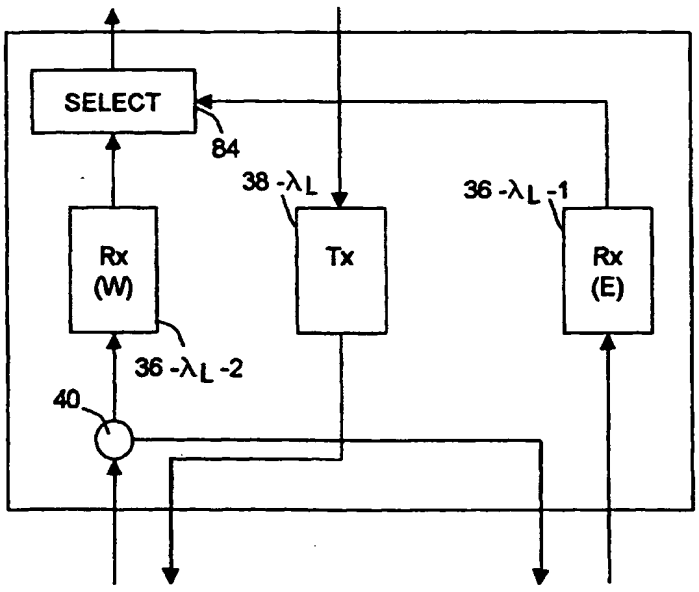
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: DUAL HOMING FOR DWDM NETWORKS IN FIBER RINGS



(57) Abstract: First and second optical fibers (26 eastbound, 26 westbound) carry information modulated on an optical carrier (λ1, λ2, ... λN). Information modulated on the carrier (λ1, λ2, ... λN) is to be recovered and transmitted at a first node (30) along the first and second optical fibers (26). The first node (30) includes apparatus for receiving and transmitting the information. The apparatus for receiving and transmitting the information includes a first receiver (either 80-λ1-1, 80-λ2-1, ... 80-λN-1 or 80-λ1-2, 80-λ2-2, ... 80-λN-2) for demodulating the information modulated on the optical carrier (λ1, λ2, ... λN) and carried on the first optical fiber (either 26 eastbound or 26 westbound), a second receiver (either 80-λ1-1, 80-λ2-1, ... 80-λN-1 or 80-λ1-2, 80-λ2-2, ... 80-λN-2) for demodulating the information modulated on the optical carrier (λ1, λ2, ... λN) and carried on the second optical fiber (either 26 eastbound or 26 westbound), a transmitter (78-λ1, 78-λ2, ... 78-λN) for modulating the information on the second optical fiber (either 26 eastbound or 26 westbound), and a splitter (40) for splitting the optical carrier (λ1, λ2, ...λN) carried on the first optical fiber (either 26 eastbound or 26 westbound). The splitter (40) is coupled to the first optical fiber (either 26 eastbound or 26 westbound) and the first receiver (either 80-λ1-1, 80-λ2-1, ... 80-λN-1 or 80-λ1-2, 80-λ2-2, ... 80-λN-2). A portion of the optical carrier (λ1, λ2, ... λN) is coupled to the first receiver (either 80-λ1-1, 80-λ2-1, ... 80-λN-1 or 80-λ1-2, 80-λ2-2, ... 80-λN-2) and another portion of the optical carrier (λ1, λ2, ... λN continues on the first optical fiber (either 26 eastbound or 26 westbound).

WO 00/76092 A1

DUAL HOMING FOR DWDM NETWORKS IN FIBER RINGS

Field of the Invention

This invention relates to networks. It is disclosed in the environment of dense wavelength division multiplexed (DWDM) networks, but is believed to be useful in other applications as well.

Background of the Invention

Referring to Fig. 1, DWDM networks 20 implemented over fiber rings 22 can carry diverse types of traffic such as, for example, SONET, ATM, IP, and so on. These networks 20 are capable of mixing different types of traffic in the same ring 22. A typical DWDM network 20 includes an arbitrary number of nodes 24 interconnected in a ring topology by a pair of optical fibers 26. One of the nodes 24 is designated the hub node 30. The other nodes 24 are referred to as terminal nodes 32. Each terminal node 32 uses one or more dedicated DWDM wavelengths $\lambda J, \lambda K, \ldots \lambda P$, $1 \leq J, K, \ldots P \leq N$, to communicate with the hub node 30. The hub node 30 has the capability to switch traffic from one wavelength $\lambda 1, \lambda 2, \ldots \lambda N$ to another. This permits communication between any pair of terminal nodes 32 on the network 20. The DWDM channel $\lambda 1, \lambda 2, \ldots \lambda N$ used to transmit traffic from the hub node 30 to a specific terminal node 32 over one of the fibers 26 is called a downlink. The DWDM channel $\lambda 1, \lambda 2, \ldots \lambda N$ of the same wavelength operating on the other fiber 26 used to transmit traffic from the terminal node 32 to the hub node 30 is called an uplink. The resulting network 20 is sometimes described as a virtual DWDM star network implemented over a fiber ring 22. The protocol used in the interaction between the hub node 30 and a specific terminal node 32 is arbitrary and independent of the protocol used by any other terminal node 32. Examples of protocols include the above-mentioned SONET/SDH, ATM and IP. Where different channels $\lambda 1, \lambda 2, \ldots \lambda N$ use different protocols, all channels $\lambda 1, \lambda 2, \ldots \lambda N$ may be assumed to be using a common protocol, for example, SONET/SDH framing, with the other protocols, for example, ATM, IP and so on, mapped into the assumed common protocol (SONET/SDH frames in this example). Both the hub node 30 and the terminal nodes 32 have the capability to effect the appropriate protocol processing on both incoming

and outgoing traffic. All nodes 24, including the hub 30, have local tributary interfaces which permit the connection of external equipment to the network 20.

A network 20 as describe above is expected to be extremely reliable and remain fully or at least partially operational despite faults of different types. Of special, although not exclusive, interest in the context of this application are the following types of faults: the failure of a transceiver in one of the nodes 24; a break or other malfunction in the physical fiber 26 that renders a segment of the ring 22 unusable; and, total or partial failure of the hub node 30.

Disclosure of the Invention

According to the invention, first and second optical fibers carry information modulated on an optical carrier between at least two nodes. At a first one of the nodes, information modulated on the carrier is to be recovered and transmitted. The first node includes a first receiver for recovering information from the optical carrier carried on the first optical fiber, a second receiver for recovering information modulated on the optical carrier carried on the second optical fiber, a transmitter for modulating the information on the second optical fiber, and a first splitter for splitting the optical carrier carried on the first optical fiber. The first splitter is coupled to the first optical fiber and the first receiver. The optical carrier carried on the first optical fiber is split by the first splitter. A portion of the optical carrier is coupled to the first receiver and another portion of the optical carrier continues on the first optical fiber.

Illustratively, the apparatus for receiving and transmitting the information includes a third receiver for recovering information modulated on the optical carrier carried on the second optical fiber, a fourth receiver for recovering information modulated on the optical carrier carried on the first optical fiber, a transmitter for modulating information on the first optical fiber, and a splitter for splitting the optical carrier carried on the second optical fiber. The splitter is coupled to the second optical fiber and the third receiver. A portion of the optical carrier is coupled to the third receiver and another portion of the optical carrier continues on the second optical fiber.

Illustratively, the apparatus includes a third node. The third node includes a fifth receiver for recovering information modulated on the optical carrier

and carried on the first optical fiber, a sixth receiver for recovering information modulated on the optical carrier and carried on the second optical fiber, a third transmitter for recovering information on the second optical fiber, and a third splitter for splitting the optical carrier carried on the first optical fiber. The third splitter is coupled to the first optical fiber and the fifth receiver. A portion of the optical carrier is coupled to the fifth receiver and another portion of the optical carrier continues on the first optical fiber.

Illustratively, the second node includes means for recovering the optical carrier from, and returning the optical carrier to, the first optical fiber.

Illustratively, the second node includes means for recovering the optical carrier from, and returning the optical carrier to, the second optical fiber.

Illustratively, the apparatus further includes a fourth node for recovering the optical carrier from, and returning said optical carrier to, the first optical fiber.

Illustratively, the fourth node includes means for recovering the optical carrier from, and returning the optical carrier to, the second optical fiber.

Illustratively, the first receiver and the second receiver are coupled to a selection function which selects between the optical carrier received over the first optical fiber and the optical carrier received over the second optical fiber.

Illustratively, the third receiver and the fourth receiver are coupled to a selection function which selects between the optical carrier received over the first optical fiber and the optical carrier received over the second optical fiber.

Brief Description of the Drawings

The invention may best be understood by referring to the following detailed description and accompanying drawings which illustrate the invention. In the drawings:

Fig. 1 illustrates a technique for overcoming the failure of a transceiver module in a fiber optic network;

Fig. 2 illustrates a technique for overcoming the failure of a transceiver in a fiber optic network having interconnected rings;

Fig. 3 illustrates a network constructed according to the invention;

Fig. 4 illustrates a characteristic of networks constructed as illustrated in Fig. 3;

Fig. 5 illustrates the logical topology of the characteristic illustrated in Fig. 4;

Fig. 6 illustrates a characteristic of networks constructed as illustrated in Fig. 3;

Fig. 7 illustrates certain functions of a system constructed according to the invention;

Fig. 8 illustrates a characteristic of networks constructed according to the invention;

Fig. 9 illustrates a high-level functional diagram of a component of a system constructed according to the invention;

Fig. 10 illustrates a high-level functional diagram of a component of a system constructed according to the invention;

Fig. 11 illustrates certain details of a system constructed according to the invention;

Fig. 12 illustrates certain details of a system constructed according to the invention;

Fig. 13 illustrates a characteristic of networks constructed according to the invention; and,

Fig. 14 illustrates a characteristic of systems constructed according to the invention.

Detailed Descriptions of Illustrative Embodiments

The failure of a transceiver module 34 can be overcome by having a second, redundant transceiver 34 in each node 24 for each wavelength accessed by that node 24. A degree of protection against fiber 26 breaks can be provided by having each node 24 transmit each of its associated wavelengths λJ, λK, . . . λP in both directions around the ring 26, and having the destination node 24 select the better copy. Thus, a combined solution for these problems may be to have two transceivers 34 at each node 24 for each wavelength accessed by that node 24, one receiving and transmitting in one direction (which will sometimes be referred to herein as

eastbound) around the ring 26, and the other receiving and transmitting in the other direction (which will sometimes be referred to herein as westbound) around the ring 22.

However, the failure of a hub node 30 still threatens the reliability of the network, since the hub node 30 affects both traffic around the ring 22 and the connection of the ring 22 to other parts of the network 20. An effective solution to the problem of failure of a hub node 30 is to provide a backup for the hub node 30 in the form of a second, redundant hub 30. Providing a second hub node 30 is referred to in the art as "dual homing." This application relates to a cost-effective implementation of dual homing in the environment of DWDM networks in fiber rings 22.

A solution to the above-described problems is to have at each node 24 two transceivers 34 per associated wavelength. The two transceivers 34 at each node 24 transmit to/receive from opposite directions, westbound and eastbound. Referring to Fig. 2, dual homing is employed where two rings 22-1 and 22-2 are interconnected to provide greater fault resiliency. Two diverse paths are provided from a node 24-x on a first one, 22-1, of the rings to a node 24-y on the second ring 22-2. A hub node 30 is provided at each interconnection between the rings 22-1 and 22-2. The second ring 22-2 may be a DWDM ring like the first, or may be, for example, a SONET ring. Duplicating an entire hub node 30 may be expensive, given the high cost of DWDM transmitters. It must be remembered that a hub node 30 terminates all DWDM wavelengths in the network and therefore potentially has a large number of transmitters.

A cost-effective method for implementing dual homing in this environment achieves a 50% reduction in the required number of transmitters compared to duplicating an entire hub node 30, without sacrificing the reliability of the network 20. Referring to Fig. 3, each terminal node 32 sends two copies of its traffic, one to each of two hub nodes 30 on the network. Each hub node 30 effects the cross-connect function on all terminal node 32 traffic. Traffic intended for other terminal nodes 32 on the same fiber optic ring 22 is sent on the corresponding downlinks, along with traffic originating in the hub node 30's tributaries. Traffic intended for the hub node 30's local tributary ports is forwarded to those ports. Each

terminal node 32 receives two copies of the downlink, one from each hub node 30, and selects the better received one using a conventional selection method.

In a dual-interconnection configuration, a hub node 30 is located at each interconnection point. Each terminal node 32 sends two copies of its traffic, one to each hub node 30. Each hub node 30 effects the cross-connect function on all terminal node 32 traffic. Traffic intended for other terminal nodes 32 within the same fiber optic ring 22 is sent on the corresponding downlinks. Each hub node, for example, hub node 30-1-1, on the transmitting ring, for example, ring 22-1, sends its copy of the inter-ring traffic to its matching interconnection hub node, for example, hub node 30-2-1, on the receiving ring, for example, ring 22-2. In the receiving ring 22-2, the destination terminal node 32 receives the traffic from both hub nodes 30 on its ring 22-2 and selects the better-received signal using a conventional selection method. This is illustrated in Fig. 4. This logical topology, which may be called a "dual-homed star" topology, is illustrated in Fig. 5.

In order to enhance the reliability of the illustrated system, it is desirable to have each hub node 30 receive both uplinks from each terminal node 32. In other words, each hub node 30 drops the uplink it receives, but also continues that uplink to the other hub node 30. This is illustrated in Fig. 6. Each hub node 30 selects the best received copy of each uplink using the selection method and uses the best received copy. When this topology is used, each hub node 30 receives at least one copy of each uplink even when a fiber cut or a failed transmitter disrupts the reception of the other uplink at that hub 30. Using this strategy, which is sometimes called "drop and continue" functionality, also enhances the robustness of a network including interconnected rings 22-1, 22-2. For example, such a network can withstand two simultaneous fiber cuts, one in each ring 22. Drop and continue functionality is used in SONET UPSR rings for these reasons. In SONET networks, the function is implemented electronically. The optical signal of the uplink is converted to an electrical signal and duplicated, one of the duplicate electrical signals becoming a "drop" signal and the other becoming a "continue" signal. The "continue" signal is then retransmitted using another transmitter 38 to the other hub node 30. A similar implementation could be used for hub nodes 30 in DWDM rings 22.

Fig. 7 illustrates functions of a hub node 30 for each DWDM wavelength. As may be appreciated, this approach requires two receivers 36 and two transmitters 38 per wavelength. The high cost of DWDM transmitters 38 can make such a strategy rather expensive. In order to eliminate one of the two transmitters 38 the illustrated approach employs optical drop and continue functionality. This is illustrated in Fig. 8. An optical coupler/splitter 40 is used to split the power of the arriving uplink. Some of the power is then directed to the local receiver 36 and the rest is continued to the other hub node 30. The need for a second transmitter 38 is thus overcome. This results in reducing by 50% the number of required transmitters 38 for the two hub nodes 30, while still meeting all the reliability requirements of the dual homing strategy. For example, the network is protected against the failure of a transceiver 34. Each terminal node 32 has two transceivers 34, and is able to send and receive even if one of them fails. Each hub node 30 has two receivers 36 per wavelength, and so is not affected by the loss of one of them.

The loss of a transmitter 38 in one of the hub nodes 30 will not disrupt traffic either, since the transmitter 38 in the other hub node 30 can still transmit the downlink to the destination terminal node 32. The network is protected against fiber 26 cuts. Each terminal node 32 receives two copies of its downlink on completely diverse paths. Likewise each hub node 30 receives two copies of each uplink on completely diverse paths. Thus, no single fiber cut can disrupt the interconnection of the two rings 22. The network is also protected against the loss of a hub node 30. The functions of each hub node 30 are substantially completely duplicated by the other hub nodes 30. Thus the network remains functional even when one of the hub nodes 30 fails partially or completely.

Fig. 9 illustrates a high-level functional diagram of terminal nodes 32. A processing subsystem 41 provides protocol processing appropriate to a particular application. Examples include SONET/SDH multiplexers and ATM multiplexers. The processing subsystem 41 provides electrical signals to an optical subsystem 42, to be transmitted as the uplink on (a) DWDM channel(s) λJ (, λK, . . . λP) associated with that terminal node 32, and receives electrical signals derived from the associated downlink DWDM channel(s) λJ (, λK, . . . λP). The processing subsystem 41 typically also has external ports of different types in order to connect external devices

which use the transport services of network 20. The optical subsystem 42 implements the optical add/drop function for the DWDM channel(s) λJ (, λK, . . . λP). It also incorporates the required transceivers 34. A control subsystem 44 manages, configures and monitors the operation of the processing and optical subsystems 41 and 42, respectively.

Fig. 10 illustrates a high-level functional diagram of a hub node 30. A processing subsystem 46 provides protocol-related processing functions such as the cross-connect/switching function and protocol processing for wavelengths λ1, λ2, . . . λN generated by hub node 30. In case of a SONET/SDH application, the processing subsystem 46 provides the functionality of a SONET/SDH cross-connect, as well as all SONET/SDH-related protocol processing. In the case of an ATM application, the processing subsystem 46 provides the functionality of an ATM VPX and the associated protocol processing. The processing subsystem 46 provides to an optical subsystem 48 an electrical channel for each DWDM channel λ1, λ2, . . . λN generated by node 30. The processing subsystem 46 receives the electrical signals derived from all incoming DWDM optical uplink signal λ1, λ2, . . . λN. The processing subsystem 46 typically also has external ports of different types in order to connect external devices which use the transport services of the network. The optical subsystem 48 has the capability to generate/terminate all the DWDM channels λ1, λ2, . . . λN being used in the network 20. The optical subsystem 48 incorporates multiplexing/ demultiplexing functionality for the DWDM channels λ1, λ2, . . . λN, as well as suitable transmitters and receivers. A control subsystem 54 manages, configures and monitors the operation of the processing and optical subsystems 46, 48, respectively.

Fig. 11 illustrates certain details of an implementation of a dual-homed DWDM ring 22. An optical add/drop multiplexer, or OADM, 60-1, 60-2 is able to drop a specific wavelength λD, $1 \leq D \leq N$, from a DWDM combined signal on the fiber and route the dropped wavelength λD to a DWDM transceiver module 34-1, 34-2, respectively. The optical signal having the same wavelength λD generated by the DWDM transceiver 34-1, 34-2, respectively, is inserted by the OADM 60-1,60-2, respectively, into the aggregate DWDM signal λ1, λ2, . . . λN on the fiber. Each OADM 60 is assigned to a specific DWDM wavelength λD, and passes all other wavelengths unaffected. OADMs 60 are commercially available from several

vendors. DWDM transceiver 34 is a set including a receiver 36 and a transmitter 38, both for a specific wavelength λD. The transmitter 38 transforms an electrical signal generated, for example, by the processing subsystem 41, into an optical signal at a wavelength λD. The receiver 36 transforms an optical signal at wavelength λD to an electrical signal and provides it to the processing subsystem 41. Such transmitters 38 and receivers 36 are commercially available from several vendors.

Fig. 12 illustrates an implementation of an optical subsystem 48 of the hub node 30 in a dual-hub configuration. A DWDM multiplexer 70-1, 70-2 multiplexes several optical signals, each having a different wavelength λ1, λ2, . . . λN, into a single fiber output. DWDM multiplexers 70 are commercially available from several vendors. A DWDM demultiplexer 72-1, 72-2 separates a DWDM signal carried on a fiber 26 and containing several optical channels, each of a different wavelength λ1, λ2, . . . λN, into separate channel outputs λ1, λ2, . . . λN on separate optical fibers 74. DWDM demultiplexers 72 are also commercially available from several vendors. An optical channel module, or OCM, 76-λL, $1 \leq L \leq N$, is provided for each wavelength λ1, λ2, . . . λN, respectively. Each OCM 76-λL incorporates one DWDM transmitter 38-λL and two receivers 36-λL-1 and 36-λL-2 for the corresponding wavelength λL. Such receivers 36-λL-1 and 36-λL-2 and transmitters 38-λL are commercially available from several vendors. There are two configurations of OCMs 76-λL, the eastern configuration 76-λL-E, and the western configuration 76-λL-W. Fig. 13 illustrates the western configuration OCM 76-λL-W. The incoming signals from two DWDM demultiplexers 72-1, 72-2 are coupled to the receivers 36-λL-1 and 36-λL-2. The resulting electrical signals are evaluated 84 for quality using, for example, the SONET overhead provisions, and the better quality one is provided to the processing subsystem 46. The western incoming signal is duplicated using a splitter 40, for example, an optical coupler, and transmitted to the eastern output. Again, this is an optical drop and continue operation. Such optical couplers 40 are commercially available from several vendors. The electrical signal provided by the processing subsystem 46 is transmitted on the western output. The description of the eastern configuration OCM 76-λL-E is identical to the western configuration OCM 76-λL-W, except that east and west are reversed. That is, the eastern incoming signal

is continued through a splitter 40 to the western output, and the signal generated by the transmitter 78-λL is sent to the eastern output.

Different OCMs 76 within the same hub node 30 can be configured differently. The choice of a configuration for a specific OCM 76 depends on the relative location of the associated terminal node 32 with respect to the two hub nodes 30. This is illustrated in Fig. 14. Terminal node 32-1 is located to the east of hub node 30-1 and to the west of hub node 30-2. Therefore the OCM 76-λL-E in hub node 30-1 associated with terminal node 32-1 will have an eastern configuration, while the OCM 76-λL-W in hub node 30-2 associated with terminal node 32-1 will have a western configuration. The result is that the copy of the signal transmitted by terminal node 32-1 in the direction of hub node 30-1 will be received by hub node 30-1 and continued to hub node 30-2 around the ring 22 in one direction. The copy of the signal transmitted by terminal node 32-1 in the direction of hub node 30-2 will be received by hub node 30-2 and continued to hub node 30-1 around the ring 22 in the other direction. Each hub node 30 will receive two copies of the signal generated by terminal node 32-1, one from each direction of the ring 22. Terminal node 32-2 is located to the west of hub node 30-1 and to the east of hub node 30-2. Therefore the OCM 76-λL-W associated with terminal node 32-2 in hub node 30-1 will have a western configuration. The OCM 76-λL-E associated with terminal node 32-2 in hub node 30-2 will have an eastern configuration.

CLAIMS:

1. In combination, first and second optical fibers for carrying information modulated on an optical carrier, at least two nodes at a first one of which information modulated on the carrier is to be recovered and transmitted, the first node including apparatus for receiving and transmitting the information, the apparatus for receiving and transmitting the information including a first receiver for recovering the information from the optical carrier carried on the first optical fiber, a second receiver for recovering information modulated on the optical carrier carried on the second optical fiber, a transmitter for modulating information on the second optical fiber, and a first splitter for splitting the optical carrier carried on the first optical fiber, the first splitter coupled to the first optical fiber and the first receiver.

2. The apparatus of claim 1 further including a third node, the third node including apparatus for receiving and transmitting the information, the apparatus for receiving and transmitting the information including a third receiver for recovering information from the optical carrier carried on the first optical fiber, a fourth receiver for recovering information from the optical carrier carried on the second optical fiber, a second transmitter for modulating information on the second optical fiber, and a second splitter for splitting the optical carrier carried on the first optical fiber, the second splitter coupled to the first optical fiber and the third receiver.

3. The apparatus of claim 1 wherein the second node includes means for recovering said optical carrier from, and returning said optical carrier to, the first optical fiber.

4. The apparatus of claim 2 wherein the second node includes means for recovering said optical carrier from, and returning said optical carrier to, the first optical fiber.

5. The apparatus of claim 3 wherein the second node includes means for recovering said optical carrier from, and returning said optical carrier to, the second optical fiber.

6. The apparatus of claim 4 wherein the second node includes means for recovering said optical carrier from, and returning said optical carrier to, the second optical fiber.

7. The apparatus of claim 1 wherein the apparatus for receiving and transmitting the information includes a third receiver for recovering information from the optical carrier carried on the second optical fiber, a fourth receiver for recovering information from the optical carrier carried on the first optical fiber, a transmitter for modulating information on the first optical fiber, and a splitter for splitting the optical carrier carried on the second optical fiber, the splitter coupled to the second optical fiber and the third receiver.

8. The apparatus of claim 2 wherein one of the first and third nodes includes a fifth receiver for recovering information from the optical carrier carried on the second optical fiber, a sixth receiver for recovering information from the optical carrier carried on the first optical fiber, a third transmitter for modulating information on the first optical fiber, a third splitter for splitting the optical carrier carried on the second optical fiber, the third splitter coupled to the second optical fiber and the fifth receiver.

9. The apparatus of claim 3 wherein the apparatus for receiving and transmitting the information includes a third receiver for recovering information modulated on the optical carrier and carried on the second optical fiber, a fourth receiver for recovering information modulated on the optical carrier and carried on the first optical fiber, a transmitter for modulating information on the first optical fiber, and a splitter for splitting the optical carrier carried on the second optical fiber, the splitter coupled to the second optical fiber and the third receiver.

10. The apparatus of claim 4 wherein one of the first and third nodes includes a fifth receiver for recovering information modulated on the optical carrier and carried on the second optical fiber, a sixth receiver for recovering information modulated on the optical carrier and carried on the first optical fiber, a third transmitter for modulating information on the first optical fiber, and a third splitter for splitting the optical carrier carried on the second optical fiber, the third splitter coupled to the second optical fiber and the fifth receiver.

11. The apparatus of claim 5 wherein the apparatus for receiving and transmitting the information includes a third receiver for recovering the information modulated on the optical carrier and carried on the second optical fiber, a fourth receiver for recovering information modulated on the optical carrier and carried

on the first optical fiber, a transmitter for transmitting information on the first optical fiber, and a splitter for splitting the optical carrier carried on the second optical fiber, the splitter coupled to the second optical fiber and the third receiver.

12. The apparatus of claim 6 wherein one of the first and third nodes includes a fifth receiver for recovering information modulated on the optical carrier and carried on the second optical fiber, a sixth receiver for recovering information modulated on the optical carrier and carried on the first optical fiber, a third transmitter for transmitting information on the first optical fiber, and a third splitter for splitting the optical carrier carried on the second optical fiber, the third splitter coupled to the second optical fiber and the fifth receiver.

13. The apparatus of claim 1 wherein the first receiver and the second receiver are coupled to a selection function which selects between the optical carrier from the first optical fiber and the optical carrier from the second optical fiber.

14. The apparatus of claim 2 wherein the first receiver and the second receiver are coupled to a selection function which selects between the optical carrier from the first optical fiber and the optical carrier from the second optical fiber.

15. The apparatus of claim 14 wherein the third receiver and the fourth receiver are coupled to a selection function which selects between the optical carrier from the first optical fiber and the optical carrier from the second optical fiber.

16. The apparatus of claim 3 wherein the first receiver and the second receiver are coupled to a selection function which selects between the optical carrier from the first optical fiber and the optical carrier from the second optical fiber.

17. The apparatus of claim 4 wherein the first receiver and the second receiver are coupled to a selection function which selects between the optical carrier from the first optical fiber and the optical carrier from the second optical fiber.

18. The apparatus of claim 17 wherein the third receiver and the fourth receiver are coupled to a selection function which selects between the optical carrier from the first optical fiber and the optical carrier from the second optical fiber.

19. The apparatus of claim 5 wherein the first receiver and the second receiver are coupled to a selection function which selects between the optical carrier from the first optical fiber and the optical carrier from the second optical fiber.

20. The apparatus of claim 6 wherein the third receiver and the fourth receiver are coupled to a selection function which selects between the optical carrier from the first optical fiber and the optical carrier from the second optical fiber.

21. The apparatus of claim 20 wherein the first receiver and the second receiver are coupled to a selection function which selects between the optical carrier from the first optical fiber and the optical carrier from the second optical fiber.

22. The apparatus of claim 1, 3, 5, 7, 9 or 11 wherein the second node includes means for recovering said optical carrier from, and returning said optical carrier to, the second optical fiber.

23. The apparatus of claim 22 further including a third node for recovering said optical carrier from, and returning said optical carrier to, the first optical fiber.

24. The apparatus of claim 2, 4, 6, 8, 10 or 12 wherein the second node includes means for recovering said optical carrier from, and returning said optical carrier to, the second optical fiber.

25. The apparatus of claim 24 further including a third node for recovering said optical carrier from, and returning said optical carrier to, the first optical fiber.

26. The apparatus of claim 1, 3, 5, 7, 9 or 11 further including a third node for recovering said optical carrier from, and returning said optical carrier to, the first optical fiber.

27. The apparatus of claim 2, 4, 6, 8, 10 or 12 further including a fourth node for recovering said optical carrier from, and returning said optical carrier to, the first optical fiber.

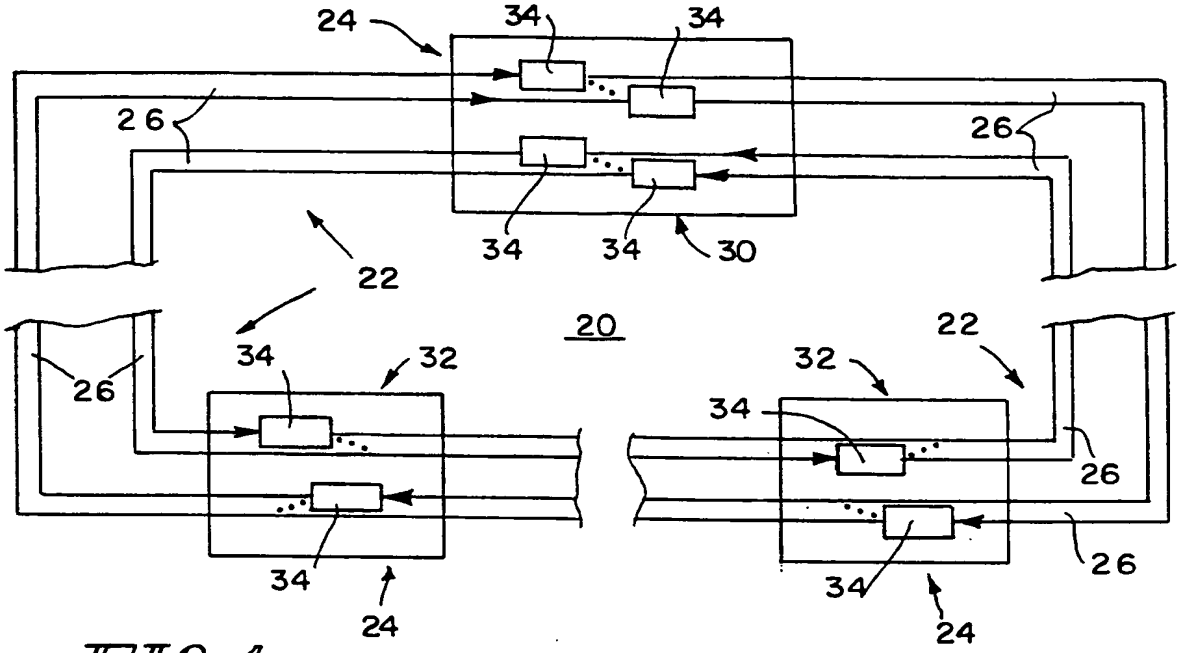


FIG. 1

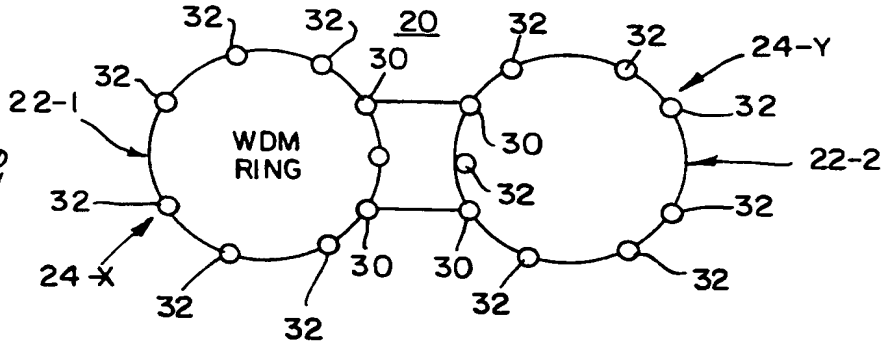


FIG. 2

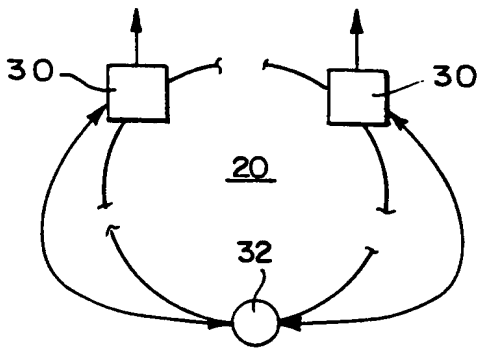
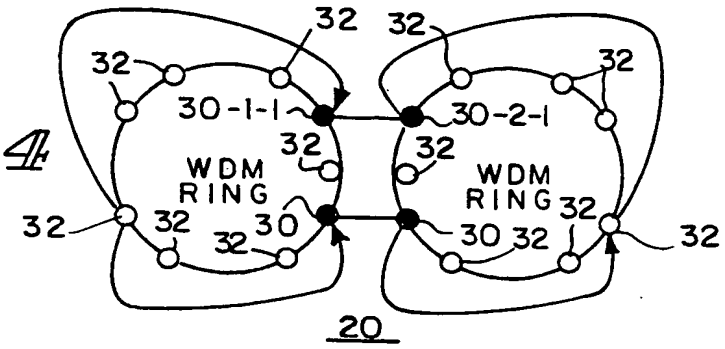


FIG. 3

FIG 4



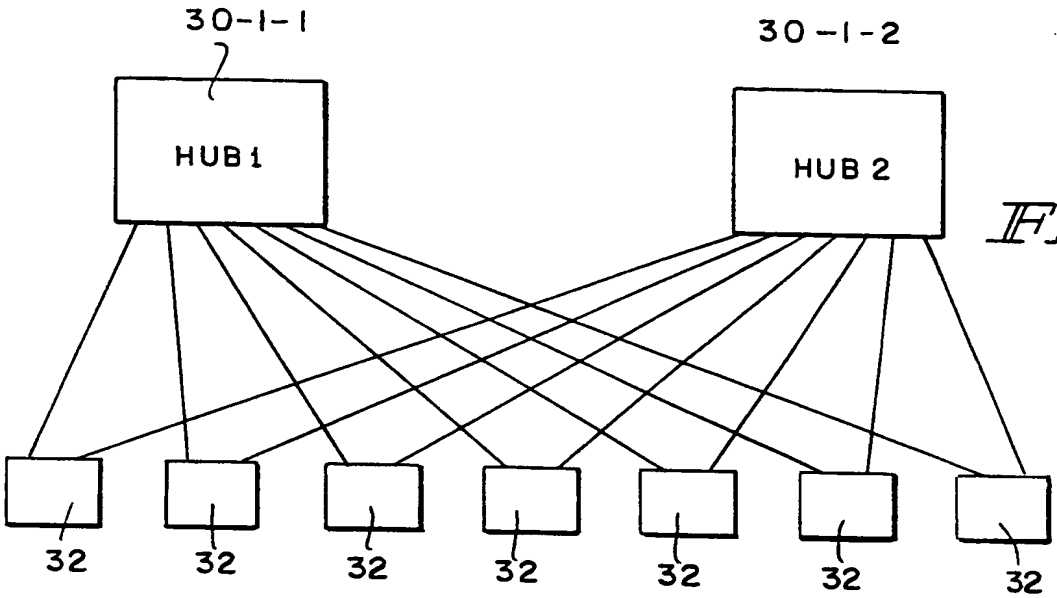


FIG 5

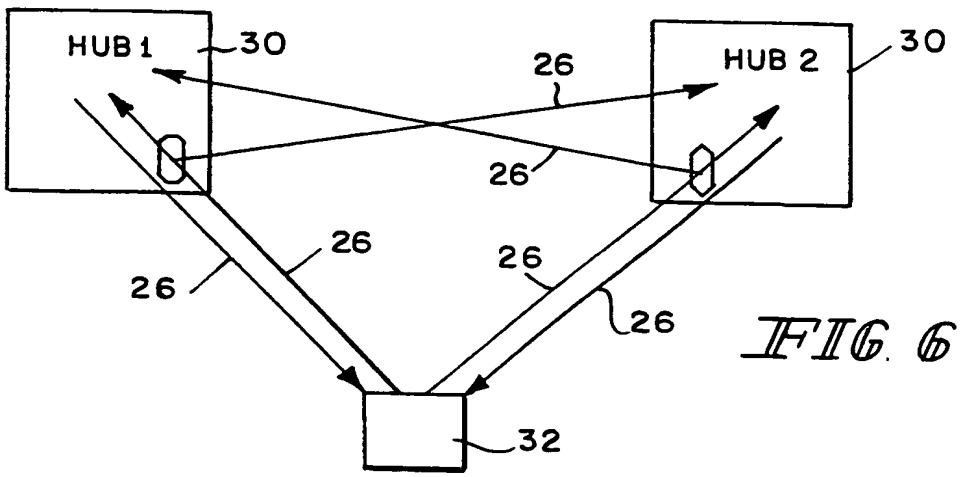


FIG 6

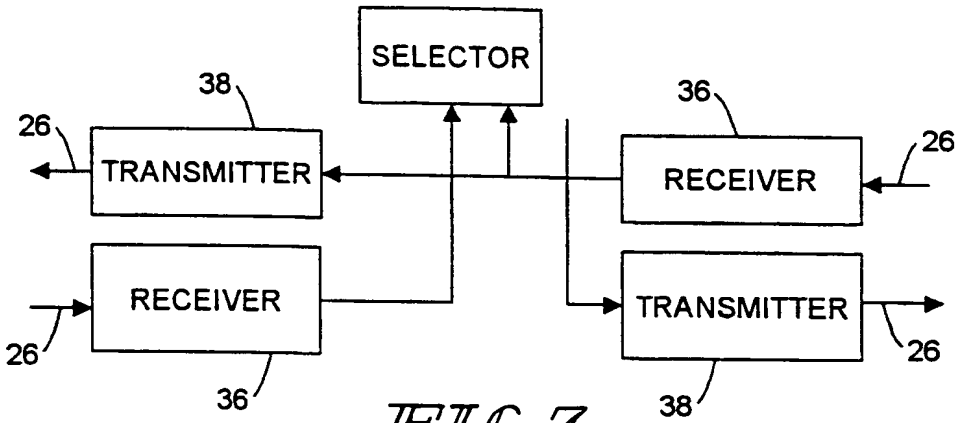


FIG. 7

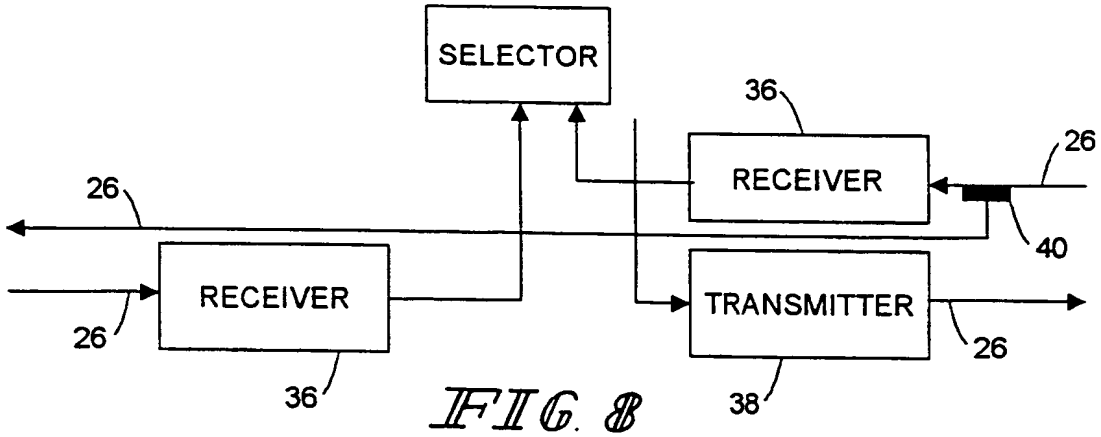


FIG. 8

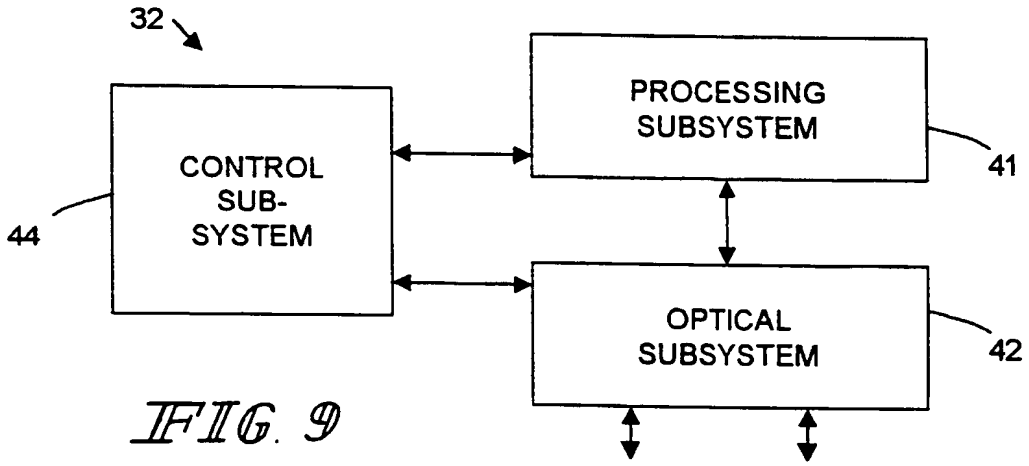


FIG. 9

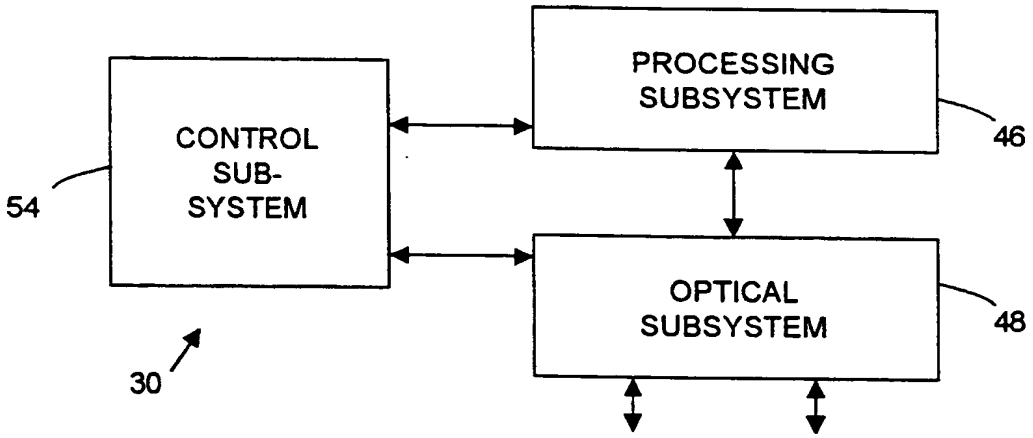

PROCESSING SUBSYSTEM
46
CONTROL SUB-SYSTEM
54
OPTICAL SUBSYSTEM
48
30

FIG. 10

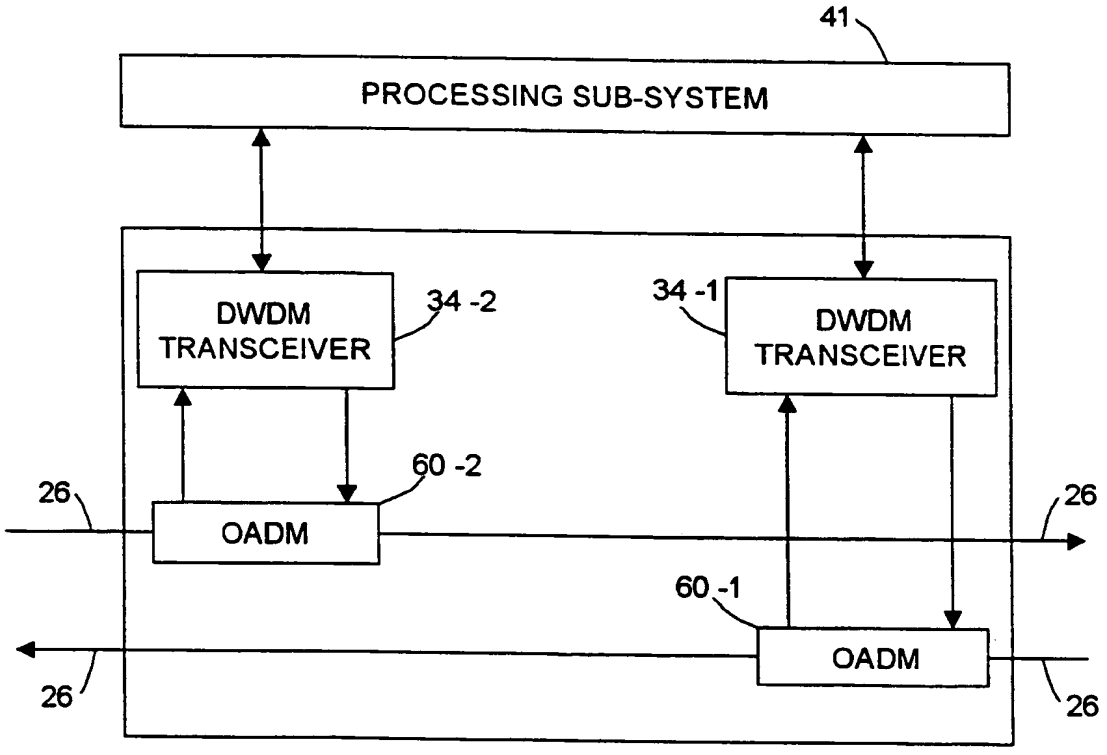

41
PROCESSING SUB-SYSTEM
DWDM TRANSCEIVER
34 -2
34 -1
DWDM TRANSCEIVER
60 -2
26
OADM
26
60 -1
OADM
26
26

FIG. 11

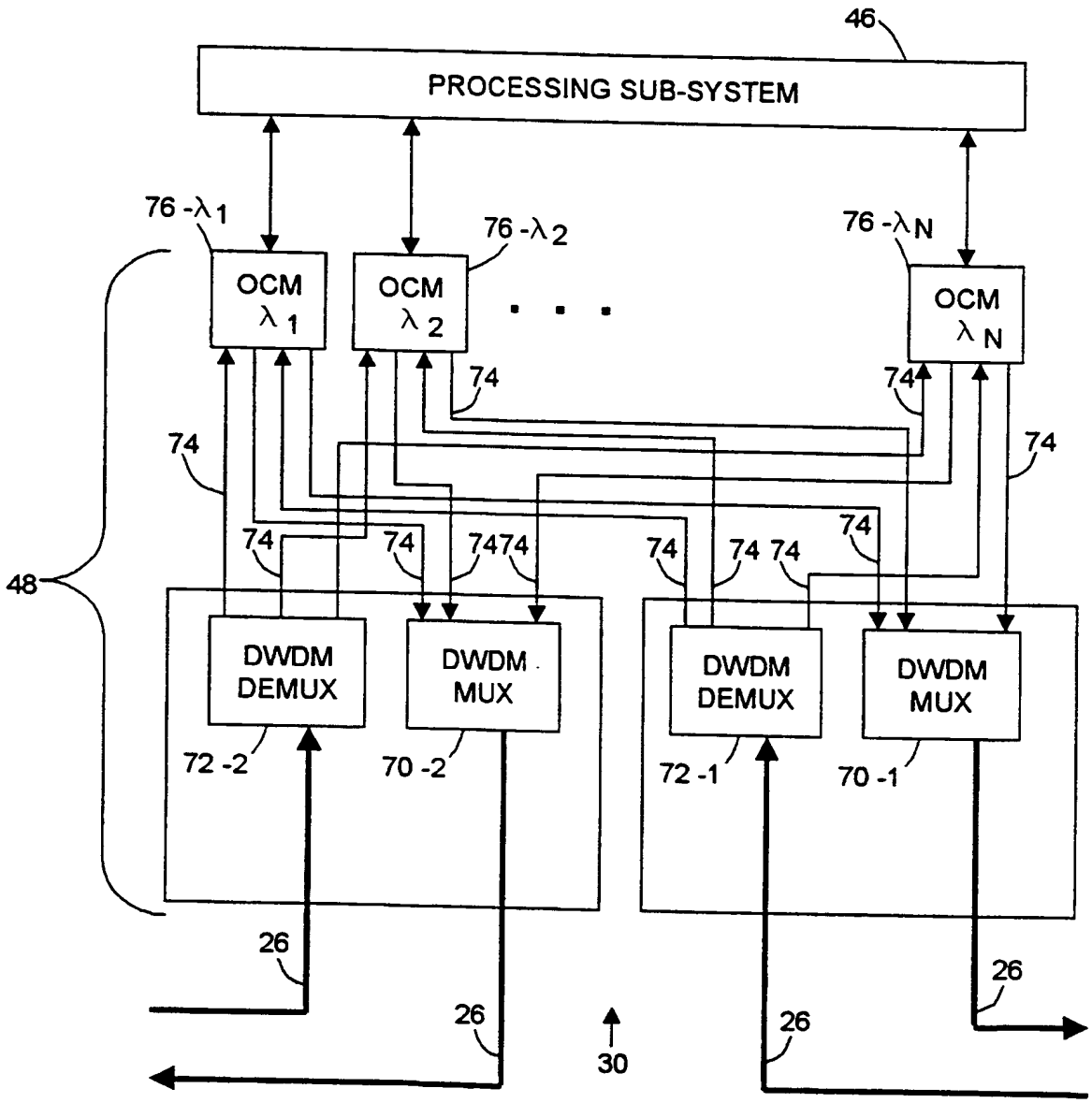

46
PROCESSING SUB-SYSTEM
76 -λ1
76 -λ2
76 -λN
OCM λ1
OCM λ2
OCM λN
74
48
DWDM DEMUX
DWDM MUX
DWDM DEMUX
DWDM MUX
72 -2
70 -2
72 -1
70 -1
26
30

FIG. 12

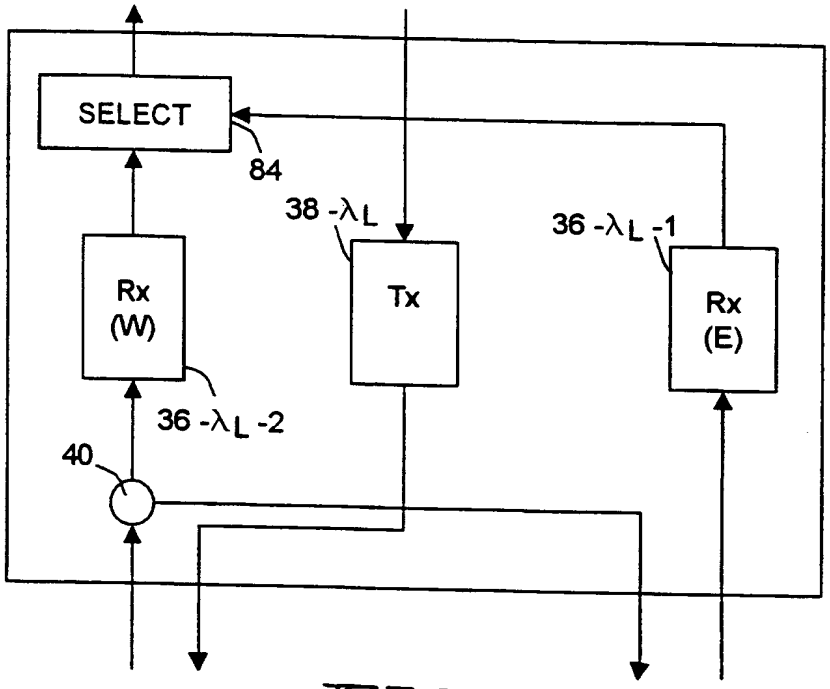


FIG. 13

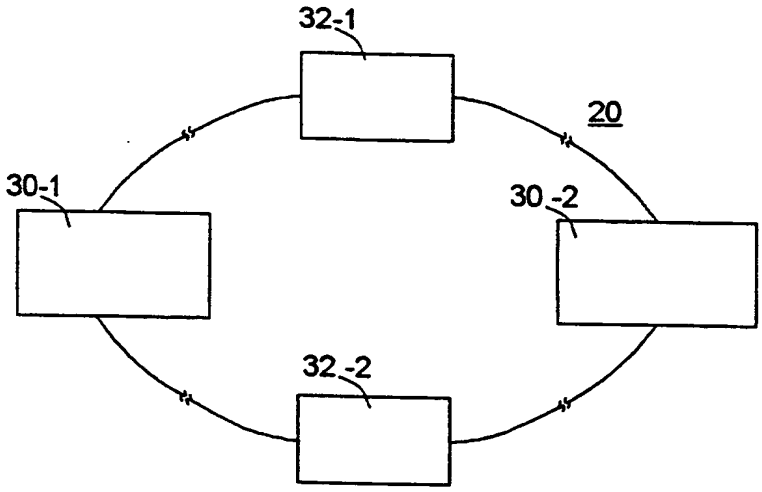


FIG. 14

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/00105

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :H04B 10/00, 10/04, 10/06, 10/12, 10/28
US CL :359/118, 119, 152, 154, 164

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 359/118, 119, 152, 154, 164

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

IEEE DATABASE
search term: ring network, node, transceiver

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,647,035 A (CADEDDU et al) 08 JULY 1997, FIGURES 1-6	1-27
Y	US 4,482,980 A (KOROWITZ et al) 13 NOVEMBER 1984, FIGURES 1, 2, AND 4	1-27
Y	US 5,406,401 A (KREMER) 11 APRIL 1995, FIGURES 1 AND 2	1-27
Y	US 4,704,713 A (HALLER et al) 03 NOVEMBER 1987, FIGURES 2A, 3	1-27
Y	US 4,837,856 A (GLISTA, JR) 06 JUNE 1989, FIGURES 2, 5	1-27

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 16 MAY 2000	Date of mailing of the international search report 28 AUG 2000
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3988	Authorized officer JASON CHAN Telephone No. (703) 305-4729

Form PCT/ISA/210 (second sheet) (July 1998)*